Tribhuvan University

Institute of Science and Technology

Model Question Paper

Bachelor Level/First Year/ Second Semester/ Science — Full Marks: 80

Computer Science and Information Technology (CSC 152) — Pass Marks: 24

(Discrete Structure) — Time: 3 hours.

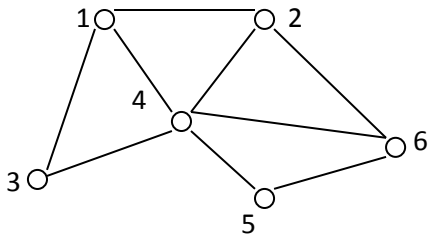
Attempt all questions.

Group A (10x2=20)

1. A restaurant displays the signs "Good food is not cheap", and competing restaurant displays the signs "Cheap food is not good". Are the two restaurants saying the same things?
2. Show that $(p \vee q) \wedge [\neg p \wedge \neg q]$ is a contradiction.
3. Given the following grammar, what is the language accepted by this grammar?

$$S \rightarrow xy$$
$$S \rightarrow zA$$
$$S \rightarrow Az$$
$$A \rightarrow y$$

4. Make the regular expressions to identify the identifiers. Mention your assumptions clearly.
5. State the Pigeon Hole principle. Find the minimum number of students in a class to be sure that three of them are born in the same month.
6. A man has six friends. How many ways he may invite one or more of them to a dinner?
7. Suppose that a connected planar simple graph has 20 vertices, each of degree 3. Into how many reasons does a representation of this planar graph split the plane?
8. Is the following graph bipartite? Discuss.

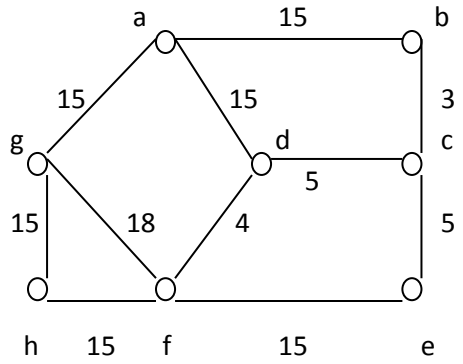


9. Write the expression $\{[(a + b) \times c] \times (d + e)\} - [f - (g \times h)]$ as a tree and then express the result in operator prefix notation.
10. Draw the binary search tree for the following words Ask, Art, Ate, Able, Alto, Also, Avid, Ant.

Group B [5 x 4=20]

11. Differentiate between existential and universal quantifier with suitable examples.
    OR
    Show that it is a valid conclusion from the premises $p \rightarrow q, p \rightarrow r, r \rightarrow s, \neg s$ and $p \vee q$.
12. Define deterministic finite state automata. Construct a DFA whose language is the set of strings that ends with 111 and contains odd number of one's.

13. Define the binomial coefficient. Write the general term of the binomial expression. Also show that the sum of the binomial coefficients is equal to 2^n.
14. How can you show that two graphs are isomorphic? Discuss invariants that can be used to show that two graphs are not isomorphic with suitable example.
15. Determine a railways network of minimal cost for the cities in figure below and represent the resultant network in spanning tree.



Group C [5x8]

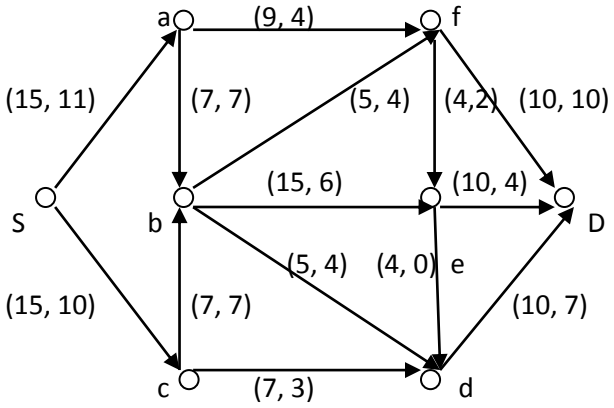
16. Explain tautologies, contradictions and contingencies with suitable example.
17. Verify rules of inferences with suitable examples.

    OR

    State the second principle of mathematical induction. Show that $f_1^2 + f_2^2 + \cdots + f_n^2 = f_n f_{n+1}$, whenever n is a positive integer. Here f_is are i^{th} Fibonacci numbers.
18. What do you mean by difference equation and its boundary condition? Solve $a_{n+2} - 5a_{n+1} - 6a_n = 2$ with initial condition $a_0 = 1$ and $a_1 = -1$.
19. What is shortest path problem? Discuss Dijkstra's algorithm for finding the shortest path in a weighted graph with at least 15 vertices and 20 edges and show each step using Dijkstra's algorithm to find shortest path between any two vertices of your choice.

    OR

    What is Euler's formula for planar graphs? How can Euler's formula for planar graphs be used to show that a simple graph is non-planar.
20. Find maximal flow for the network shown in the figure below.



Tribhuvan University

Institute of Science and Technology

2065

Bachelor Level/ First Year /Second Semester/ Science — Full Marks: 80

Computer Science and Information Technology (CSc. 152) — Pass Marks: 32

(Discrete Structure) — Time: 3 Hours.

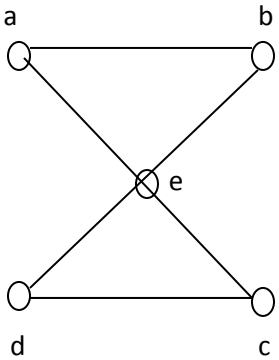
Candidates are required to give their answers in their own words as for as practicable.

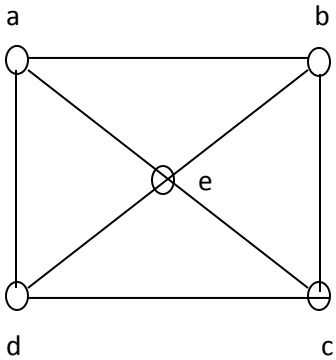
The figures in the margin indicate full marks.

Attempt all questions:

Group A (10x2=20)

1. Given propositions p and q, define conjunction and disjunction of them.
2. Define existential quantifications with suitable examples.
3. State which rule of inference is basis of the following argument: "It is below freezing and raining now, therefore, it is below freezing now."
4. State and prove the Pigeonhole principle.
5. Define linear homogeneous recurrence relation.
6. Define the terms a language over a vocabulary and the phrase-structure grammar.
7. Distinguish between deterministic and nondeterministic finite state automaton.
8. Define the complete graph K_n on n vertices and the complete bipartile graph $K_{m,n}$ with suitable examples.
9. Which of the undirected graphs in the following figure have an Euler circuit? Explain.





10. What is the chromatic number of the complete bipartile graph $K_{m,n}$, where m and n are positive integers.

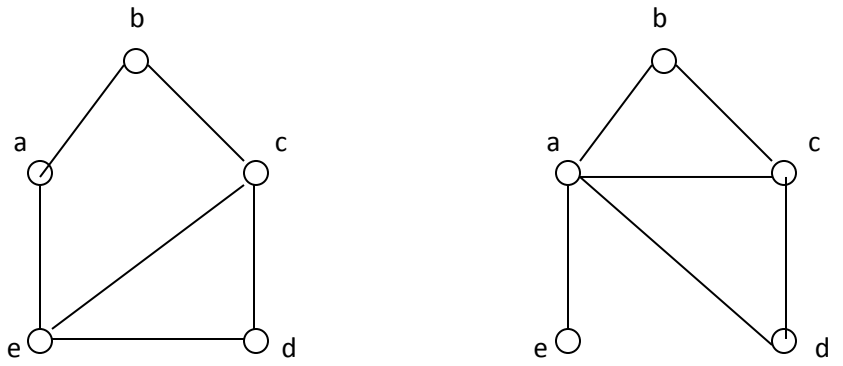
Group B (5x4=20)

11. Explain the 4 rules of inference for quantified statements.
12. Find an explicit formula for the Fibonacci numbers, with recursion relation $f_{n-1} + f_{n-2}$ and $f_0 = 0, f_1 = 1$.
13. Define finite-state with output with suitable examples.

OR

Define deterministic finite state automata. When are two finite state automata equivalent? Give an example.

14. Show that the graphs in the following figure are not isomorphic.



What can you say about the complexity of graph isomorphism algorithms in terms of complexity?

15. Prove that an undirected graph is a tree if there is a unique simple path between any two of its vertices.

Group C (5x8=40)

16. Explain Tautologies, contradiction and contingencies with suitable examples.

OR

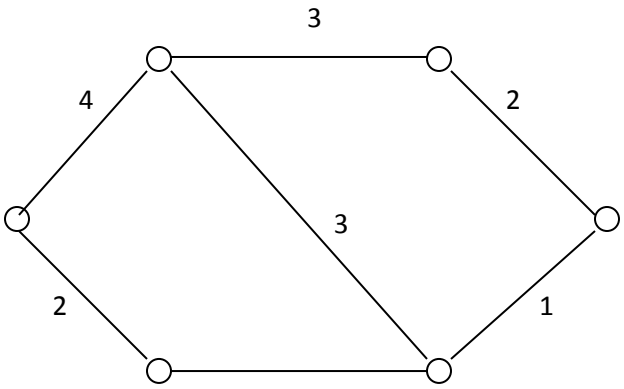
Explain the method of proving theorems by direct, indirect, contradiction and by cases.

17. Define linear homogeneous recursion relation of degree K with constant coefficient with suitable examples. What is the solution of the recurrence relation $a_n = a_{n-1} + 2a_{n-2}$ with $a_0 = 2$ and $a_1 = 7$?
18. Let G be the grammar with vocabulary $V = \{S, 0, 1\}$, set of terminals $T = \{0, 1\}$, starting symbol S, and productions $P = \{S \to 11S,\ S \to 0\}$. What is L(G), the language of this grammar?
19. Explain the concept of network flows and max-flow min-cut theorem with suitable examples.

20. Define Euler and Hamiltonian circuits and paths with examples illustrating the existence and nonexistence of them.

OR

Discuss the shortest path algorithm of Dijkstra for finding the shortest path between two vertices. Use this algorithm to find the length of the shortest path between a and z in the following weighted graph?



Give the idea of travelling salesman problem and the difficulties of solving it.

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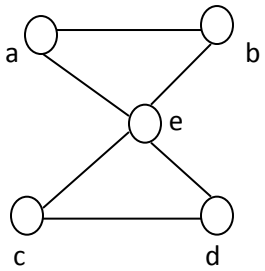
Candidates are required to give their answers in their own words as for as practicable.

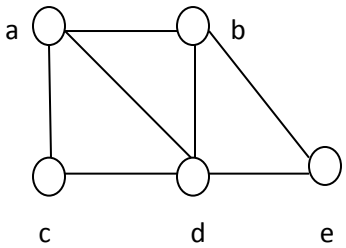
The figures in the margin indicate full marks.

Attempt all questions:

Group A (10x2=20)

1. Define proposition and its negation with an example.
2. Show that $\neg(p \vee q)$ and $\neg p \wedge \neg q$ are logically equivalent.
3. State which rule of inference is the basis of the following argument; "It is below freezing now. Therefore, it is either below freezing or raining now."
4. State the Pigeonhole principle. How many students must be in a class to guarantee that at least two students receive the same score on the final exam is graded on a scale from 0 to 100?
5. Let $\{a_n\}$ be a sequence that satisfies the recursion relation $a_n = a_{n-1} - a_{n-2}$ for $n \geq 2$ and suppose that $a_0 = 3$ and $a_1 = 5$. Find the values a_2 and a_3.
6. Let G be the grammar with vocabulary V = {S, A, a, b}, t = {a, b}, starting symbol S and production P = {S→aA, S⟶b, A⟶aa}. What is L(G), the language of this grammar?
7. Determine the kleen closures of the sets A = {0}, B = {0, 1}, C = {11}.
8. How many edges are there in a graph with 10 vertices each of degree six?
9. Which of the undirected graphs in the following have an Euler path?





10. Determine the chromatic number K_n.

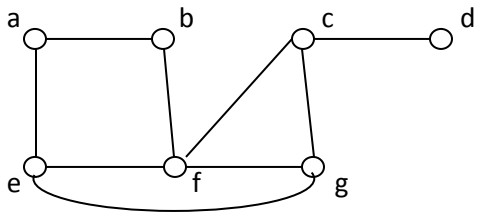
Group B (5x4=20)

11. Differentiate between existential and universal quantifiers with suitable examples.

12. Find the solution of the recursion relation $a_n = a_{n-1} + 2a_{n-2}$ with $a_0 = 2$ and $a_1 = 7$?

    OR

    Find an explicit formula for the Fibonacci numbers.
13. Define deterministic finite state automata. Construct a DFA whose language is the set of strings that ends with 111 and contains odd number of 1's.
14. Prove that an undirected graph is a tree if and only if there is a unique simple path between any two of its vertices.
15. Find a spanning tree of the simple graph in the following graph, if it exists.



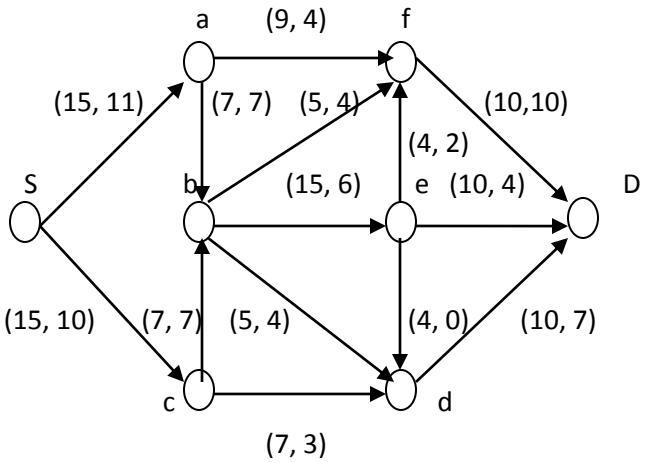
    Can there be more possibilities?

Group C (5x8=40)

16. Discuss the techniques of proofs by contradiction and by cases with suitable examples.
17. Describe linear homogeneous and linear non-homogeneous recurrence relations with suitable examples.
18. Explain non-homogeneous finite automata and language of NFA with suitable example.
19. State and prove the Max-flow and Min-cut theorem.

    OR

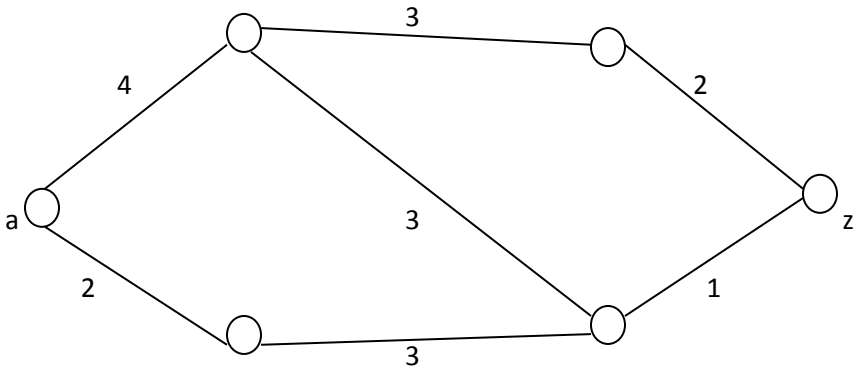
    Find a maximum flow for the network in the figure below.



20. Define Hamiltonian paths and circuits with suitable examples for the existence and nonexistence. Show that K_n has a Hamilton circuit whenever $n \geq 3$.

    OR

Write the shortest path algorithm of Dijkstra for finding the shortest path between two vertices. What is the length of shortest path between a and z in the weighted graph in the following figure?



Apply the stated algorithm for finding the solution.

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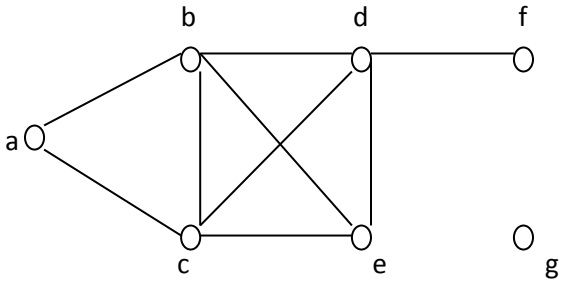
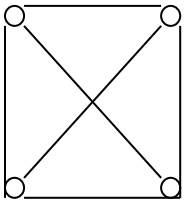
Attempt all questions.

Group A (10x2=20)

1. What do you mean by proposition? Give example to justify your answer.
2. How do you define logically equivalent propositions?
3. Give examples of addition rule and simplification rule of inference.
4. State and prove the Pigeonhole principle.
5. How many ways are there to select a first, second and third – prize winners from 10 different people?
6. Discuss the types of phrase structure grammars and their relations.
7. Give formal definition of regular expressions over a set I.
8. Verify the Handshaking theorem in the figure.



9. Is the graph K_4 planar? How?



10. Determine the chromatic number K_n.

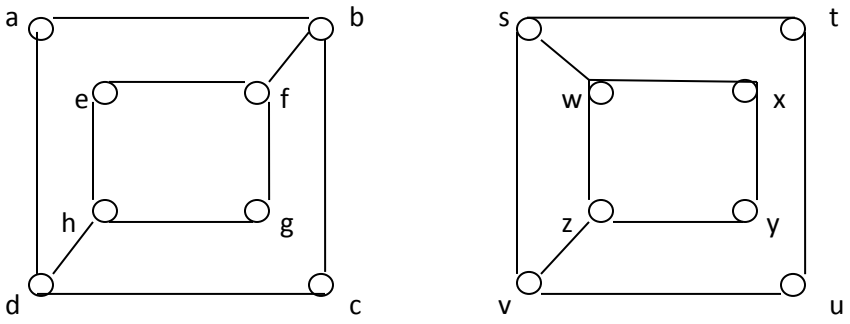
Group B (5x4=20)

11. Explain the 2 rules of inference for quantified statements and give suitable examples.

OR

Show that the propositions $pv(p \wedge r)$ and $(r \vee q) \wedge (p \vee r)$ are logically equivalent.

12. Define the binomial coefficient and give the general term of the binomial coefficient. Show that the sum of the binomial coefficient is 2^n.
13. How do you distinguish deterministic and nondeterministic finite-state automaton? Give suitable examples.
14. Determine whether the graphs shown in the following figure are isomorphic.



What can you say about the graph isomorphism algorithms in terms of efficiency?

15. Prove that a tree with n-vertices has n-1 edges.

Group C (5x8=40)

16. Discuss the techniques of direct proof indirect proof and vacuous proof for proving implications with suitable examples.
17. Find the solution to the recursion relation

$$a_n = 6a_{n-1} - 11a_{n-2} + 6a_{n-3}$$

with initial conditions $a_0 = 2$, $a_1 = 5$ and $a_2 = 15$.

OR

Suppose that a person deposits Rs. 10,000/- in a fixed account at a bank yielding 11% per year with interest compounded annually. How much will be in the account after 10 years? Solve the problem with modeling it into recursion relations.

18. What do you mean by phase-structure grammar? Let C_1 be the grammar with vocabulary V = { S, 0, 1}; set of terminals T = {0, 1}, starting symbol S, and productions $P=\{S\rightarrow 11S, S\rightarrow 0\}$. Determine the language L(G) of this grammar.
19. Explain the concept of network flows and max-flow min-cut theorem with suitable examples.

OR

Define Euler circuit and Euler path with suitable examples. Give the multi-graph model of the two of Koenigaberg state a necessary and sufficient condition for Euler circuit in connection to your definitions and model.

20. Discuss the Algorithm of Dijkstra for finding the shortest path in a weighted graph between two vertices with suitable example. Moreover, explain the travelling salesman problem and the efficiency of algorithm for solving this problem.